SCIENCE

FRIDAY, JULY 12, 1895.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Prof. J. McKeen Cattell, Garrison on Hudson, N. Y.
Subscriptions and advertisements should be sent to SCIENCE, 41 N. Queen St., Lancaster, Pa., or 41 East 49th St., New York.

THE SUN.

"IT is because the secrets of the Sun," says Mr. Lockyer, "include the cipher in which the light messages from external Nature in all its vastness are written, that those interested in the 'new learning,' as the chemistry of space may certainly be considered, are anxious to get at and possess them." But even more significant to dwellers on the Earth are the heat radiations of the Sun, because they are determinant in all animal and vegetable life, and are the original source of nearly every form of terrestrial energy recognized by mankind. Through the action of the solar heat-rays the forests of palæozoic ages were enabled to wrest carbon from the atmosphere and store it in forms afterward converted by Nature's chemistry into peat and coal; through processes incompletely understood, the varying forms of vegetable life are empowered to conserve, from air and soil, nitrogen and other substances suitable for and essential to the life maintenance of animal creatures. Breezes operant in the production of rain and in keeping the air from hurtful contamination; the energy of water, in stream and dam and fall; trade winds facilitating commerce between the continents; oceanic currents modifiying coast climates (and no less the tornado, the waterspout, the typhoon, and other manifestations of natural forces, excepting earthquakes, frequently destructive to the works of man), all are traceable primarily to the heating power of the Sun's rays acting upon those readily movable substances of which the Earth's exterior is in part composed.

The Sun, cosmically speaking, is simply a star, but the nearest fixed star is 275,000 times more remote; so that the Sun's vastly greater brightness is, for the most part, due to mere proximity. Still, the distance of the Sun is by no means easy to conceive or

illustrate. Recalling that the distance round the Earth's equator is about 24,000 miles, ten times this gives the distance of the Moon, which is practically inconceivable; but the Sun is 390 times more remote. As the two bodies are about the same in apparent size, it follows that the Sun's actual diameter is about 390 (accurately 400) times greater than the Moon's.

The available methods of ascertaining the Sun's distance, more than a dozen in number, may be divided into three classes: (1) by geometry or trigonometry; (2) by gravitational effects of Sun, Moon and planets; (3) by the velocity of transmission of light. The first includes transits of Venus, and near approaches of the Earth to Mars, or to small planets exterior thereto, at which times the distances of these bodies from the Earth are not difficult to measure. Adopting, with Professor Young, the number 100 as indicating a method which would insure absolute accuracy, this class of determinations will range all the way from 20 to 90. The second class of methods, too mathematical for explanation here, depends on the Earth's mass, and their present value may be expressed as 40 to 70; but the peculiar nature of one of them (utilizing the disturbances which the Earth produces in the motion of Venus and Mars) offers an accuracy continually increasing, so that 200 years hence it alone will have settled the Sun's distance with a precision entitled to the number 95. But the best methods now available are embraced in the third class, which employ the velocity of light (determined by actual physical experiment), and their present worth is about 80 or 90. The problem of the Sun's distance is one of the noblest ever grappled by the mind of man; and no one of the numerous elements with which it is complexly interwoven can yet be said to have been determined with the highest attainable precision.

An admirable summary of investigation of the Sun's distance is given by Dr. Gill as an introduction to Mrs. Gill's *Six Months in Ascension* (London, 1880), an account of an expedition to that island three years previously. The value of the Sun's parallax, 8″.848 ± 0″.013, determined by Professor Newcomb (*Washington Observations*, 1865), and now become classic, is adopted in all the national astronomical ephemerides except the French, which adheres to a larger value of Le Verrier. Independent determinations of this constant below given show the measure of modern precision in this important field of research; and the relations of the values to each other will be apparent on recalling that the addition of 0″.01 to the Sun's parallax is equivalent to diminishing his distance about 105,000 miles:

			″ ″
(1880) TODD	Velocity of Light		8.808 ± 0.006
(1881) PUISEUX	Contact and Micrometer Observations, Transit of Venus, 1874		8.8
(1881) TODD	American Photographs, Transit of Venus, 1874		8.883 ± 0.034
(1885) NEWCOMB	Velocity of Light		8.794
(1885) OBRECHT	French Photographs, Transit of Venus, 1874		8.81 ± 0.06
(1887) CRULS	Brazilian Observations, Transit of Venus, 1882		8.808
(1887) E. J. STONE	British Contact-Observations, Transit of Venus, 1882		8.832 ± 0.024
(1888) HARKNESS	American Photographs Transit of Venus, 1882		8.842 ± 0.012
(1889) HARKNESS	Planetary Masses		8.795 ± 0.016
(1890) BATTERMANN	Lunar Occultations		8.794 ± 0.016
(1890) NEWCOMB	Re-discussion Transits of Venus, 1761 and 1769		8.79 ± 0.034
(1892) AUWERS	German Heliometer Observations, Transits of Venus, 1874 and 1882		8.880 ± 0.022
(1892) GILL	Opposition of Small Planets	(12) Victoria	8.809
(1893) GILL		(80) Sappho	8.811
(1894) GILL & ELKIN		(7) Iris	8.825 ± 0.008

Also several other values of this important constant have been derived, and there is an increasing tendency to cluster round the figure 8″.81.

Professor Harkness published in 1891 a laborious paper entitled *The Solar Parallax and its Related Constants* (Washington Observations, 1885), in which this quantity is treated, not as an independent constant, but as "entangled with the lunar parallax, the

constants of precession and nutation, the parallactic inequality of the Moon, the lunar inequality of the Earth, the masses of the Earth and Moon, the ratio of the solar and lunar tides, the constant of aberration, the velocity of light and the light-equation." Collating the great mass of astronomical, geodetic, gravitational and tidal results which have been accumulating for the past two centuries and applying the mathematical process known as a 'least square adjustment,' he derives the value $8''.809 \pm 0''.006$, giving for the mean distance between the centres of Sun and Earth, 92,797,000 miles. A valuable bibliography of the entire subject concludes Professor Harkness's paper.

Professor Newcomb, in his *Elements of the Four Inner Planets and the Fundamental Constants of Astronomy* (Washington, 1895), on which his new tables of the principal planets of the solar system are founded, derives from his discussion of all existing data a definitive value for the Sun's parallax equal to $8''.790$. This important paper is a supplement to the *American Ephemeris* for 1897.

Possible changes of the Sun's diameter from time to time have been critically investigated by Dr. Auwers, of Berlin, and Professor Newcomb, with negative results; nor are the observations yet made sufficient to disclose any difference between equatorial and polar diameters. The heliometer affords the best means of measuring the Sun's apparent diameter or the angle subtended by its disk. The orbit of the Earth being elliptical, this diameter changes in the inverse proportion of the Earth's varying distance from the Sun; at the beginning of the year it is $32' 32''$ and $31' 28''$ early in July, the mean value being $32' 0''$. Supposing the form of the Earth's orbit unknown, daily measures of the Sun's varying diameter would alone, in the course of a year, enable the precise determination of the figure of the orbit, so accurately can these measures now be made. When at its mean distance from the Earth, the linear equivalent of one second of arc at the Sun is 450 miles. The present uncertainty in the solar diameter does not much exceed $2''$; that is to say about 900 miles, or quite approximately $\frac{1}{1000}$ of the entire diameter. Dr. Auwers's recent value of the semi-diameter is $15' 59''.63$; and if we take the mean distance of the Sun at 93,000,000 miles, this numerical relation gives the Sun's diameter 865,350 miles.

A simple relation between the Sun's mass and its dimensions relatively to the Earth enables us to determine that the force of gravity at the Sun's surface is $27\frac{2}{3}$ times greater than it is here; so that while a body on the Earth falls only 16.1 feet in the first second of time, at the Sun its fall in a corresponding interval would be no less than 444 feet. If a hall clock were transported to the Sun, its leisurely pendulum would vibrate more than five times as rapidly. So great is the Sun's mass that a body falling freely toward it from a distance indefinitely great would, on reaching the Sun, have acquired a velocity of 383 miles per second. The great Krupp gun exhibited at the World's Fair in 1893, if fired from Chamounix in the direction of Mont Blanc, at an elevation of 44°, would propel its projectile of 475 pounds in a curve meeting the earth at Pre-Saint-Didier, $12\frac{1}{2}$ miles from Chamounix, and whose highest point would be more than a mile above the summit of Mont Blanc. If we could suppose the same gun to be fired similarly on the Sun, so great is the force of gravity there that the projectile would be brought down to rest about half a mile from the muzzle.

From groups of the faculæ, Dr. Wilsing has found that the Sun's equator revolves in $25^d.23$; but these observations are exceedingly difficult, and a repetition of the work is desirable. Professor Young and Dr. Crew have determined the period of rotation of the Sun's equator by means of the

spectroscope, utilizing that technicality called Doppler's principle. This means that the spectra from opposite sides of the Sun (the east side coming toward the Earth, and the west receding from us) are optically brought alongside each other; then careful measurement of the amount of divergence of a given line in the two spectra forms the basis for calculating the rapidity of rotation. M. Duner, of Lund, Sweden, carrying this research still farther, into high solar latitudes, finds for the equatorial regions a period of sidereal rotation equal to $25^d.46$, in close correspondence with the determinations of Carrington and Spoerer from the spots alone; while the slowing down as the poles are approached is remarkably verified; for his results give, for the rotation period at latitude 75°, no less than $38^d.54$. M. Duner's observations were made near the time of minimum spots, and it would be interesting to repeat the determination near the epoch of maximum spottedness.

The Sun's axis is inclined 83° to the plane of the Earth's orbit; and if prolonged northward to the celestial sphere, the axis would intersect it near the third magnitude star δ Draconis, so that in March the Sun's north pole is turned farthest from the Earth, in September it is inclined 7° toward us. Spectroscopic study of the sun-spots shows that their inferior brilliance is due in part to a greater selective absorption than obtains in the photosphere generally. Continuous and systematic records of the solar spots are now kept at Greenwich (in connection with Dehra Dun, India), at Potsdam near Berlin, at Chicago, and elsewhere. Exceedingly fine photographs of sun-spots and the solar surface have been obtained at Potsdam (*Himmel und Erde*, ii., 1890, 24).

Also at Meudon, Paris, M. Janssen has had extraordinary success in photographing the Sun's surface in detail, and the granulation is very sharply defined in his originals. In viewing the Sun with a telescope this granulation can be satisfactorily seen with a magnifying power of about 400 or 500, under good atmospheric conditions.

While the 42 years' faithful work of Schwabe, as revised by Wolf and collated with other and scattering results, gives an average sun-spot period of $11\frac{1}{9}$ years, there are great irregularities. During the latter half of the 17th century, the ordinary progress of the spot cycle appears to have intermitted; the intervals between maxima have varied from 8 to $15\frac{1}{2}$ years, and between minima from 9 to 14 years. True interpretation of this indicates with an approach to certainty that the cause of the periodicity does not lie in planetary or any exterior agency, but that it is seated in the Sun itself.

The solar prominences, or hydrogen flames, are drawn in full sun-light, by means of a spectroscope adjusted delicately on the edge of the Sun, this instrument reducing the sky-glare, without dispersing very much the light of the prominence itself. This method has now been in common use more than a quarter century. But by means of the spectro-heliograph devised by Professor Hale, of the University of Chicago, the hindering effects of our atmosphere are in greater part evaded; and he is enabled to secure on a single plate (with single exposure) not only the photosphere and sun-spots, but the chromosphere and protuberances. Also the same instrument (which utilizes monochromatic light, or light of a single color only) has demonstrated that the faculæ, which to the eye are ordinarily seen only near the Sun's limb, actually extend all the way across the disk of the Sun, in approximately the regions of greatest spot-frequency. Professor Hale's progressive methods of solar research will soon give us large accumulations of facular observations, from which the

laws of their appearance may be finally determined, and their connection with the formation of spots and prominences satisfactorily made out. Similar results from the work of M. Deslandres, of the Paris Observatory, are given in Mr. Maunder's paper in *Knowledge*, for January, 1895.

Both spots and prominences have a well recognized variation in heliographic or solar latitude; the former has been investigated by Dr. Spoerer of Potsdam, and the latter by M. Riccò of Palermo. Just before the epoch of a minimum (1888, for example) the spots are seen nearest the Sun's equator; coincidently with the minimum these circum-equatorial spots cease, and a series breaks out afresh in high solar latitudes. Thenceforward to the time of the next minimum the mean latitude of the spots tends to decline continuously. This fluctuation is called 'the law of zones.' Dr. Spoerer's investigations further show an occasional predominence of spots in the Sun's southern hemisphere not counterbalanced by a corresponding appearance in the northern. Also, during the last half of the seventeenth century and the early years of the eighteenth, there seems to have been a remarkable interruption of the ordinary course of the spot cycle, and the law of zones, too, was apparently in abeyance. The latitude variations of the prominences follow quite closely the fluctuations of the spots, although exhibiting a greater divergence between the Sun's two hemispheres than the spots do.

Independently of his light and heat, the Sun's supreme right to rule his family of planets is at once apparent from his superior size, and from his vastly greater mass. Relative weights of common things readily give a notion sufficiently precise: let the ordinary bronze cent represent the weight of the Earth; Mercury and Mars, then, the smallest planets, would, if merged in one, equal an old-fashioned silver three-cent piece; Venus, a silver dime; Uranus, a gold double-eagle and a silver half-dollar (or, what is about the same thing in weight, a silver dollar, half dollar, and a quarter dollar taken together); Neptune, two silver dollars; Saturn, eleven silver dollars; Jupiter, rather more than two pounds avoirdupois (37 silver dollars); while the sun, outweighing 750 times all the planets taken together, would somewhat exceed the weight of the long ton.

As the Sun shines with inconceivably greater power than any terrestrial source, an idea of its total light is difficult to convey intelligibly in terms of the ordinary standards adopted by physicists. Its intrinsic brightness, or amount of light per square unit of luminous surface, exceeds the glowing carbon of the electric arc light about $3\frac{1}{2}$ times, or the glowing lime of the calcium light about 150 times. "Even the darkest part of a sun-spot outshines the lime light" (Young). Some rude notion of the total quantity of light received from the Sun is perhaps obtainable on comparison with the average full moon, whose radiance the Sun exceeds 600,000 times. In consequence of absorption of the Sun's light by its own atmosphere, the Earth receives very much less than it otherwise would; while if the absorbing property of the atmosphere were entirely removed, the Sun would (according to Professor Langley) shine two or three times brighter, with a color decidedly blue, resembling the electric arc. As a further effect of this absorption, the intrinsic brightness at the edge is $\frac{2}{5}$ that of the centre of the disk (according to Professor Pickering); and Dr. Vogel makes the actinic or photographic intensity only $\frac{1}{7}$ for the same region. While this shading off towards the edge is at once apparent to the eye, when the entire Sun is projected on a screen, the rapid actinic gradation is more marked in photographs of the Sun, which strongly show the effect of under-exposure near the

limb, if the central regions of the disk have been rightly timed.

Kirchhoff in 1858 formulated the following principles of spectrum analysis: (1) Solid and liquid bodies (also gases under high pressure) give, when incandescent, a continuous spectrum; (2) gases under low pressure give a discontinuous but characteristic bright-line spectrum; (3) when white light passes through a gas, this medium absorbs rays of identical wave-length with those composing its own bright-line spectrum. These principles fully account for the discontinuous spectrum of the Sun, crossed, as it is, by the multitude of Fraunhofer lines. But it must be observed that the relative position of these lines will vary with the nature of the spectroscope used; with a prism spectroscope the relative dispersion in different parts of the spectrum varies with the material of the prism; with a grating spectroscope (in which the dispersion is produced by reflection from a gitter or grating, ruled upon polished speculum metal with many thousand lines to the inch), the dispersion is wholly independent of the material of the gitters, and it is called, therefore, the normal solar spectrum. Compared with this a prismatic spectrum has the red end unduly compressed, and the violet end as unduly expanded.

Rutherfurd, assisted by Chapman, ruled excellent gratings mechanically; but the last degree of success has been attained by Professor Rowland, of Baltimore, whose ruling engine covers specular surfaces, either plane or concave, six inches in diameter with accurate lines, up to 20,000 to the inch. The concavity of the gratings vastly simplifies the accessories of the spectroscope for researches in which they are applicable. So great is the dispersion obtainable that the solar spectrum, as photographed by Rowland with one of these gratings and enlarged three-fold, is about forty feet in length. The superiority of his ruling engine consists primarily in the accurate construction and perfect mounting of the screw, which has 20 threads to the inch, and is a solid cylinder of steel, about 15 inches long and $1\frac{1}{8}$ inches in diameter. (Article 'Screw,' *Encyclopædia Britannica*, 9th edition.) The perfect gratings ruled with this engine are now supplied to physicists all over the world.

By means of a spectroscope properly arranged with suitable accessories, the Sun's spectrum has been both delineated and photographed alongside of the spectra of numerous terrestrial substances. Foremost among recent investigators in this field, and in mapping the solar spectrum, are Thollon in France, Lockyer and Higgs in England, Thalén in Sweden, Smyth in Scotland, and in America Rowland, Young, Trowbridge and Hutchins. Their research, together with that of previous investigators, principally Kirchhoff and Angström, Vogel and Fievez, has led to the certain detection of at least 35 elemental substances in the Sun, among which are:

(Al) Aluminium.	(Ag) Silver.
(Ba) Barium.	(C) Carbon.
(Cd) Cadmium.	(Ca) Calcium.
(Co) Cobalt.	(Cu) Copper.
(Cr) Chromium.	(Fe) Iron.
(H) Hydrogen.	(Mg) Magnesium.
(Mn) Manganese.	(Ni) Nickel.
(Na) Sodium.	(Si) Silicon.
(Sc) Scandium.	(Ti) Titanium.
(V) Vanadium.	(Zn) Zinc.

Hydrogen, iron, nickel, titanium, calcium and manganese are the most strongly marked. All the oxygen lines of the solar spectrum are due to the oxygen of our atmosphere. Chlorine and nitrogen, so abundant on the Earth, and gold, mercury, phosphorus and sulphur, are as yet undiscovered. Also the solar spectrum appears to indicate the existence of many metals in the Sun not now recognized upon the Earth; but it must be remembered that our globe is known only

superficially, and there is every reason for believing that the Earth, if heated to incandescence, would afford a spectrum very like that of the Sun itself.

The chemical spectra of many metallic elements freed from impurities are not yet fully known, but these are in the process of thorough investigation by Rowland, and Kayser and Runge of Hanover. Their researches will make possible a more searching comparison with the solar spectrum, hundreds of the dark lines in which are due to absorption by the Earth's atmosphere, and are consequently called telluric lines. Especial studies of these have been made by MM. Janssen, Thollon and Cornu, Becker and McClean. Whether the solar spectrum is constant in character is not known; with a view to the determination of this question in the future, Professor Piazzi Smyth conducted a series of observations for fixing the absolute spectrum in the year 1884. Mr. Higgs, of Liverpool, studying those strikingly marked bands in the solar spectrum due to the absorption by oxygen in our atmosphere, and known as 'great *B*' and 'great A,' finds that the double lines are in rythmic groups, in harmonious sequence, capable of representation by a simple geometric construction.

Regarding the solar spectrum (prismatic) as a band of color merely, the maximum intensity of heat rays falls just below the red (at some distance inferior to the dark Fraunhofer line A); and that of light falls in the yellow (between *D* and *E*); and that of chemical or photographic activity, in the violet (between G and H); but in the normal spectrum these three maxima are brought more closely together, approaching the middle of the spectrum, which nearly coincides with the yellow D lines of sodium.

Beyond the red in the solar spectrum is a vast region wholly invisible to the human eye; but modern physicists have devised methods for mapping it with certainty. Sir John Herschel, J. W. Draper and Becquerel were the pioneers in this research, the last utilizing various phosphorescent substances upon which an intense spectrum had been projected for a long time. Direct photographic maps of the infra-red regions are very difficult, because the actinic intensity is exceeding feeble; and Abney, by means of collodion plates specially prepared with bromide of silver, has made an extended catalogue of the invisible dark bands. But Professor Langley has pushed the mapping of the infra-red spectrum to an unexpected limit by means of the bolometer, a marvellously sensitive energy-measurer of his own invention. In order to understand in outline the operation of the bolometer, or spectro-bolometer, it is necessary to recall that, as the temperature of a metal rises, it becomes a poorer conductor of electricity; as it falls its conductivity increases, iron at 300° below centigrade zero being, as Professor Dewar has shown, nearly as perfect an electrical conductor as copper. The characteristic feature of the bolometer is a minute strip of platinum leaf, looking much like an exceedingly fine hair or coarse spider web. It is about $\frac{1}{4}$ inch long, $\frac{1}{100}$ inch broad, and so thin that a pile of 25,000 strips would be only an inch high. This bolometer film, then, having been connected into a galvanometer circuit, is placed in the solar spectrum formed either by a grating or through the agency of rock salt prisms; and as it is carried along the region of the infra-red, parallel to the Fraunhofer lines, the fluctuations of the needle may be accurately recorded.

In this manner he first represented the Sun's invisible heat spectrum in an energy-curve; but his recent application of an ingenious automatic method, accessory to the bolometer, has enabled him to photograph its indications in a form precisely compar-

able with the normal spectrum. Bolography is the name given by Professor Langley to these processes which, by the joint use of the bolometer and photography, have automatically produced a complete chart of the invisible heat spectrum equal in length to ten times the entire luminous spectrum of the Sun, though indications of heat extend still farther. A fuller account of Professor Langley's significant work will be found in *Nature*, Vol. 51, (1894), p. 12, and in the new *Astrophysical Journal* for February, 1895, published at the University of Chicago. The bolometer was built by Grunow of New York, and forms part of the equipment of the astrophysical observatory of the Smithsonian Institution at Washington. So sensitive is this delicate instrument that it is competent to detect a temperature fluctuation as minute as the millionth part of a degree centigrade. It is proper to add that the researches conducted with such an instrument, often appearing remote and meaningless to a layman, are eminently practical in their bearing, as they pertain directly to the way in which the Sun affects the Earth, and man in his relations to it; and to the method of distribution of solar heat, forming thus, among other things, a scientific basis for meteorology.

At the end of the solar spectrum remote from the red is the ultra-violet region, ordinarily invisible; a portion of which may, however, be seen by receiving it upon uranium glass or other fluorescent substances. Glass being nearly opaque to the short wave-lengths of violet and ultra-violet, the optical parts of instruments for this research are made of quartz or calc-spar, or the necessary dispersion is obtained by using the diffraction grating. The superior intensity of the chemical or actinic rays in this region renders photography of especial service; and sensitive films stained with various dyes have been effectively employed. The painstaking investigations of Rutherfurd, Cornu, H. Draper, Rowland and Vogel have provided splendid maps of the invisible ultra-violet spectrum, exceeding many times the length of the visible spectrum. The farther region of the ultra-violet is pretty abruptly cut off by the absorptive action of our atmosphere.

The constant of solar heat, first investigated by Herschel and Pouillet in 1837–38, was redetermined by Professor Langley in 1881. He adopts *three calories* (small) as the solar constant, which signifies that "at the Earth's mean distance, in the absence of its absorbing atmosphere, the solar rays would raise one gramme of water three degrees centigrade per minute for each normally exposed square centimetre of its surface. * * * Expressed in terms of melting ice, it implies a solar radiation capable of melting an ice-shell 54.45 metres deep annually over the whole surface of the Earth." Professor Langley's *Researches on Solar Heat and its Absorption by the Earth's Atmosphere; A Report of the Mount Whitney Expedition*, were published as No. xv. *of the Professional Papers of the Signal Service* (Washington, 1884).

To express the solar heat in terms of energy: When the Sun is overhead, each square metre of the Earth's surface receives (deducting for atmospheric absorption) an amount of heat equivalent to $1\frac{1}{2}$ horse-power continuously. In solar engines like those of Ericsson and Mouchot about $\frac{7}{8}$ of this is virtually wasted. Of heat radiation emitted from the Sun and passing along its radius, Professor Frost finds that about $\frac{1}{4}$ part is absorbed in the solar atmosphere, which, were it removed, would allow the Earth to receive from the Sun 1.7 times the present amount. Imagine the hemisphere of our globe turned towards the Sun to be covered with horses, arranged as closely together as possible, no horse standing in the shadow of any other; then cover the opposite hemisphere with an equal number of horses: the solar energy intercepted by the

Earth is more than equivalent to the power of all these animals exerting themselves to the utmost and continuously.

It is easy to show that "the amount of heat emitted in a minute by a square metre of the Sun's surface is about 46,000 times as great as that received by a square metre at the Earth, * * * that is, over 100,000 horse-power per square metre acting continuously." * * * (Young.) If the Sun were solid coal this rate of expenditure would imply its entire combustion in about 6,000 years. The effective temperature of the Sun's surface is difficult to determine, and has been variously evaluated, from the enormously high estimates of Secchi, Ericsson and Zöllner, to the more moderate figures of Spoerer and Lane, who deduced temperatures of 80,000° to 50,000° Fahrenheit. According to Rosetti, it is no less than 18,000° Fahrenheit, an estimate probably not far wrong. M. Le Chatelier, however, in 1892, found the temperature a little short of 14,000°, and Wilson and Gray about 12,000°. Dr. Scheiner's recent observations upon the peculiar behavior of two lines in the spectrum of magnesium confirm these lower values in a remarkable way, apparently showing that the Sun's temperature lies between that of the electric arc (about 6,000°) and that of the electric spark (probably as high as 20,000°). A still later value is 40,000° C., derived by Herr Ebert of Kiel in 1895, by a method, however, involving much theoretic uncertainty.

The maintenance of this stupendous outlay of solar energy is explainable on the theory advanced by Von Helmholtz in 1856, who calculated that an annual contraction of 250 feet in the Sun's diameter will account for its entire radiation in a year—a rate of shrinkage so slow that many centuries must elapse before it will become detectable with our best instruments. Accepting this theory, Lord Kelvin estimates that the Earth cannot have been receiving the Sun's light and heat longer than 20,000,000 years in the past; and Professor Newcomb calculates that in 5,000,000 years the Sun will have contracted to one-half of its present diameter, and it is unlikely that it can continue to radiate sufficient heat to maintain life of types now present on the Earth longer than 10,000,000 years in the future. But it is now known that there are elements neglected in this computation which render a revision necessary and will probably extend this time very greatly. Assuming that solar heat is radiated uniformly in all directions, computation shows that all the known planets receive almost a two-hundred-millionth part of the entire heat given out by the Sun, the Earth's share being about $\frac{1}{10}$ of this. The vast remainder seems to us essentially wasted, and its ultimate destination is unknown.

To epitomize Professor Young's statement of the theory of the Sun's constitution, generally accepted:

(a) The Sun is made up of concentric layers or shells, its main body or nucleus being very probably composed of gases, but under conditions very unlike any laboratory state with which we are acquainted, on account of the intense heat and the extreme compression by the enormous force of solar gravity. These gases would be denser than water, and viscous, in consistency possibly resembling tar or pitch.

(b) Surrounding the main body of the Sun is a shell of incandescent clouds, formed by condensation of the vapors which are exposed to the cold of space, and called the photosphere. Telescopic scrutiny shows that the photosphere is composed of myriad 'granules' about 500 miles in diameter, excessively brilliant, and apparently floating in a darker medium.

(c) The shallow, vapor-laden atmosphere in which the photospheric clouds appear to float is called the 'reversing layer,' because

its selective absorption produces the Fraunhofer lines in the solar spectrum. It probably is somewhat less than 1,000 miles in thickness. The reversing layer contains a considerable quantity of those vapors which have given rise to the brilliant clouds of the photosphere, just as the terrestrial atmosphere adjacent to clouds is itself saturated with the vapor of water.

(d) The chromosphere and prominences are permanent gases, mainly hydrogen and helium, mingled with the vapors of the reversing layer but rising to far greater elevations than the vapors do. Jets of incandescent hydrogen appear to ascend between the photospheric clouds, much like flames playing over a coal fire. Calcium vapor is the most intensely marked of all the metals in the solar spectrum, even more so than of iron, which has over 2,000 line-coincidences, while calcium has only about 80.

(e) Still above photosphere and prominences is the corona, hitherto observable only during total eclipses, and extending to elevations far greater than any truly solar atmosphere possibly could. The characteristic green line of its spectrum, due to a substance not yet discovered on the Earth, and hence called 'coronium,' is brightest close to the Sun's limb, and during the eclipse of 1st January, 1889, it was traced outward by Professor Keeler to a distance of 325,000 miles. But much of the coronal light is known to originate in something other than the gaseous incandescence of hydrogen and coronium, because of the dark lines seen to cross its spectrum. These indicate solar light, reflected probably from small meteoric particles, possibly the debris of comets, circulating about the Sun in orbits of their own.

Dr. Huggins and Dr. Schuster maintain the view that the coronal streamers are in part due to electric discharges. The corona appears to be a very complex phenomenon, and as yet it is only in part understood. Two rival theories are now prominent; Mr. Schaeberle's mechanical theory (*Lick Observatory Reports on the Total Eclipse, 22d December, 1889*), and Professor Bigelow's theory (*The Solar Corona discussed by Spherical Harmonics*, Washington, 1889), that the coronal light is merely a phenomenon of the Sun's magnetism. But neither of these theories has yet been shown competent to undergo the ultimate test—that of predicting the general configuration of the coronal streamers at future eclipses.

Among modern solar theories may be mentioned that of Schmidt (1891), an optical theory of the solar disk, making the Sun wholly gaseous, in fact, a planetary nebula, existing in space without a definite outline anywhere, as we see it; so that the photosphere would be an apparent or optical surface merely, and not a real or natural one, such as the Sun's disk and limb seem actually to be in the telescope. The best English exposition of Schmidt's theory is that of Herr Wilczynski of Berlin, in the February (1895) number of the *Astrophysical Journal;* followed in the same issue by Professor Keeler's clear statement of certain practical objections to this theory. If Schmidt's theory were true, it is exceedingly improbable that the Sun's apparent or angular diameter would remain practically a constant quantity, as we know it does. Also may be mentioned the theory of the Sun by Dr. Brester of Delft, published in 1892, and characterized by much novelty. Rejecting the hypothesis of eruptional translation of solar matter, he conceives the Sun to be a relatively tranquil gaseous body, of essentially the same elementary composition as our Earth; and he attempts to show, in accordance with well known properties of matter, that the same cause which would keep the mass in repose must produce also 'chemical luminescence,' as he terms it. Great material eruptions, then, are merely deceptive appearances, be-

ing simply moving flashes in tranquil incandescent gases. Neither of these theories, however, is accepted to any great extent by practical students of the Sun and observers of solar phenomena.

The surface of the Sun (photosphere, spots, faculæ and prominences) is now a subject of daily study at many observatories, particularly at Potsdam, Meudon, Rome, and the Kenwood Observatory of the University of Chicago, where Professor Hale has instituted many significant innovations, in which he has been closely followed by M. Deslandres, of Paris; and observations are rapidly accumulating, the complete discussion of which ought soon to settle many points in the solar theory now disputed. But as the Sun's corona is visible only a few hours in a century, our knowledge of that object makes haste very slowly, and must continue to do so, unless the photographic method of Dr. Huggins (apparently successful in 1883, though later not), or of other investigators, shall make it possible to study the brighter streamers of the corona without an eclipse. Results of a patient series of recent attempts, however, are not encouraging. But it is well worth noting that an application of Professor Langley's bolometer, lately proposed by Professor Hale, though not yet put into execution, may still enable us to map the corona at any time by means of the minute variations in its heat from part to part. And many astronomers are hopeful that this ingenious suggestion may yet give a trustworthy outline picture of the corona in full sunlight, although the ability to picture it directly may forever be denied.

AMHERST COLLEGE. DAVID P. TODD.

CURRENT NOTES ON PHYSIOGRAPHY (XII.).

RECENT GEOGRAPHICAL SCHOOL BOOKS.

PROFESSOR SPENCER TROTTER'S 'Lessons in the New Geography' (Heath & Co., Boston, 1895) was referred to with approval in the Current Notes on Anthropology in SCIENCE for March 8th; but its geographical features are not altogether satisfactory. The spirit of the book is excellent. It does a good work in emphasizing the control that geographical conditions exercise over the distribution of plants, animals and man; but its physiographic foundation is not secure; the two brief chapters on the general forms of land and water and on climate and meteorology do not present the better modern views on these subjects; and the chapters on the geographical distribution of life, to which special attention is paid, do not satisfy the expectations of the biologist, as far as I have made inquiry. The faunal divisions recognized for America belong to the past; while the latest results, based on positive knowledge of the facts of distribution and of the facts of temperature control, are not mentioned. It is to be hoped that these deficiencies will be corrected in a later edition.

'Short Studies in Nature Knowledge,' an introduction to the science of physiography by William Gee, certified teacher of the education department (London, Macmillan, 1895), is one of a class of attractive books, whose object is to make geography better worth studying. Its entertaining chapters are well illustrated, if exception is made of certain exaggerated pictures, such as that of the Susquehanna, p. 121; but the book lacks a strong and scientific basis. The reader will probably be interested and attracted to further study; but he will not be impressed with the system and order of Nature's processes. As is so often the case, the impossible is attempted in giving an elementary explanation of the general circulation of the winds.

'A Brief Descriptive Geography of the Empire State,' by C. W. Bardeen (Bardeen, Syracuse, N. Y., 1895, 75 cents), is intended for local use, giving an account of the general topography, surface (mountains,

rivers, lakes, waterfalls, etc.), geology, climate and productions, political divisions, education, and railway journeys; the latter heading occupying a third of the book. There are numerous illustrations, many of which are well chosen and well produced. Twenty-five small outline maps are used to exhibit the distribution of various features. Yet, on the whole, the book is an empirical treatment of a rational subject. Not nearly enough is made of the physical features of the State, as to their origin on the one hand, and as to their control over conditions of life on the other hand. The attitude of the author regarding physiographic processes may be judged from an extract: "The valleys [of the Finger Lakes] seem like immense ravines, formed by some tremendous force, which has torn the solid rocks from their original beds;" a foot note adding—"The force that effected these immense changes was probably great currents of water from the N." The disregard of geological structure as a basis of geographical subdivision is indicated by the following: "Three distinct mountain masses or ranges enter the State from the S. and extend across it in a general NE. direction." Then after accounts of the Highlands and the Catskills we read: "*The Adirondacks.*—The third series of mountains enters the State from Pennsylvania and extends NE. through Broome * * * * * and Herkimer counties to the Mohawk, appears upon the N. side of that river, and extends NE., forming the whole series of highlands that occupy the NE. part of the State, generally known as the Adirondack Mountain region" (p. 19). This association of a part of the sedimentary Allegheny plateau with the crystalline Adirondacks is altogether unwarrantable, especially as the two are separated by a well defined subsequent lowland.

A common difficulty pervades these three books; they are not based on a serious, thorough, scientific study of geography.

TEAY VALLEY, WEST VIRGINIA.

THE topographical sheets of the U. S. Geological Survey for West Virginia include the path of Teay Valley, a wide-open, clay-floored trench running east and west through the hilly plateau, from the Kanawha Valley a little below Big Coal River, to the Ohio Valley a little above Huntington, but not followed by any proportionate stream. It has been stated that 'the valley is clearly enough a remnant of early erosion, when the water of the Upper Kanawha took that course to join the Ohio' (Wright, Bull. 58, U. S. G. S., 87); but this is not satisfactory, for if the master stream of the region ever followed this course, how was it ever diverted to any other course? The following alternative explanation is offered, in the hope that it may be criticized by special observation on the ground.

The diversion of one stream by another flowing in the same general direction in a region of horizontal strata is comparatively rare; if it happens, it is usually the result of the lateral swinging of a larger toward a smaller one. At the moment of contact, the larger one, which has the lower grade, laterally abstracts the smaller one, which has the higher grade. The Cumberland in western Kentucky is in some danger of this sort of abstraction by the Tennessee, and if that region were now uplifted, the abstraction might easily result from the increased lateral meandering that would be there introduced. Lateral abstraction seems to have been actually practised on the Big Coal River by the Kanawha; Teay Valley being the lower abandoned course formerly followed by the Big Coal. In France, cystalline pebbles carried by the Moselle from the Vosges mountains into the valley of the Meuse show plainly enough a former arrangement of drainage unlike the present; but the monotonous sandstones of the Alleghany plateau in the Kanawha and Big Coal River basins pro-

bably forbid the application of this test to the case of the Teay Valley. Can any other test be suggested?

W. M. DAVIS.

HARVARD UNIVERSITY.

ZOÖLOGICAL NOTES.

A MONOGRAPH OF CRINOIDS.*

THE crinoids of the Paleozoic rocks of North America are so rich and varied in form, so numerous in individuals, that they have long been the delight and the despair of naturalists. Especially is this the case with that order of the crinoids to which the name Camerata is now generally applied, the order that includes such well-known forms as the Nava Encrinite, *Actinocrinus*, and the Rose Encrinite, *Rhodocrinus*, which are common enough in our own Mountain Limestone, together with the flatter and simpler form, *Platycrinus*. For, in America, there are added to these ordinary genera such remarkable creatures as the huge *Megistocrinus;* the speared and spined *Dorycrinus;* the peculiar mushroom-like *Agaricocrinus; Strotocrinus*, like a college don in his mortar-board; *Eretmocrinus*, with its broad oar-like arms; *Pterotocrinus*, whose lofty dome is surmounted by wings; *Gilbertsocrinus*, with strange drooping appendages of unknown function, and *Batocrinus*, whose pores at the bases of the arms are equally mysterious. But this list does not include a quarter of the camerate or vaulted genera known from the Carboniferous rocks of America alone; while, if we accept the the work of Mr. S. A. Miller and kindred spirits, the long line will stretch out to the crack of doom. Such, indeed, is the variety of form, and such the rashness of interpretation of some of the more enthusiastic collectors and describers, that to us European students the subject has become one of inextricable complexity. It is, therefore, with peculiar pleasure that we learn an authoritative monograph of these wonderful and beautiful beings is shortly to be issued.

Since the year 1859, or thereby, Charles Wachsmuth, who lives at Burlington, Iowa, in the very heart of the crinoid country, has devoted his life to the study of these animals. A large collection which he made was bought for the Museum at Cambridge, Mass., by Professor Louis Agassiz, at whose invitation Wachsmuth settled at the University to take charge of the whole collection of crinoids. The first-fruits of his study were published in 1877. After a time Wachsmuth returned to Burlington and began to form a second collection; much of this he was, unfortunately for himself, forced to part with, this time to the enrichment of the British Museum, in whose galleries some of his magnificent specimens are displayed. Association with Frank Springer enabled him to continue his collection and his studies, so that the series of fossil crinoidæ made by the two friends is unrivalled even by the great collections of London, Harvard or Stockholm, and their 'Revision of the Paleozoic Crinoids' has long held the front rank among all works on the subject. In their knowledge of the writings of others, in their accurate discrimination of generic and specific characters, and in their important contributions to the morphology of the crinoids, these gentlemen have shown themselves most fitted to prepare that desired necessity, a monograph of the fossil crinoids of North America. The magnitude of the task, the failing health of the elder worker and the business cares of the younger, have prevented the completion of more than a portion, that, namely, which deals with the Crinoidæ Camerata. The text of this portion alone will fill between 600 and 700 quarto pages, while no less than eighty-three plates, of extreme beauty, have been drawn by A. M. Westergren, J.

* Reprinted from proofs for *Natural Science* contributed by the Editor.

Ridgway and C. R. Keyes, under the immediate supervision of the authors. It is fitting that Professor Alexander Agassiz and the Museum of Comparative Zoölogy at Harvard should undertake the publication of this monograph. It will appear as one of the Memoirs of the Museum, so soon as the plates can be photographically reproduced from the original pencil drawings—that is, it is hoped, early in 1896. The price will be thirty dollars. As the edition will be limited, intending subscribers are requested to send their names to Professor Agassiz at the earliest possible date. A work of such usefulness and importance needs no recommendation from us; we can only hope that the enterprise of the publishers and the devotion of the workers may meet with due appreciation from the scientific public, and that Charles Wachsmuth and Frank Springer may be spared many years of health and leisure, to place the crown on this worthy monument of American paleontology.

THE FISHES OF THE COLORADO BASIN.

In a paper on the 'Fishes of the Colorado Basin,' just published by the U. S. Fish Commission, Messrs. Evermann and Rutter have brought together all the published information accessible to them concerning the geographic distribution of the fishes of that river basin. Although the Colorado basin is one of the largest in the United States, the number of square miles drained being not less than 225,000, the number of species of fishes found in it is but 32. This number has been taken at a single haul with a 30-foot seine in Bean Blossom Creek, a little stream near Bloomington, Indiana.

The 32 species of the Colorado basin represent 5 families, as follows:

Catostomidæ, or suckers, 8; *Cyprinidæ*, or minnows, 19; *Salmonidæ*, or trout and whitefish, 2; *Pœciliidæ*, or top-minnows, 2; and *Cottidæ*, or blobs, 1.

The *Cyprinidæ*, it will be noticed, constitute considerably more than half the entire fish-fauna.

Of the 18 genera represented, *Gila*, *Tiaroga*, *Meda*, *Plagopterus* and *Xyrauchen* are peculiar to that river basin, and a sixth genus, *Lepidomeda*, is known only from the Colorado and the Great Basin in southwestern Nevada, where it was discovered by the Death Valley expedition.

Of the 32 species all but 7 are thus far known only from this basin.

The extreme paucity of the fish-fauna of the Colorado basin will be apparent when it is recalled that 80 different species are known from the basin of the Rio Grande, 140 from that of the Missouri and 130 from the Wabash basin. Only 2 species (*Rhinichthys cataractæ dulcis* and *Coltus bairdi punctulatus*) are found in both the Colorado and Missouri basins, only 2 species (*Agosia oscula* and *Agosia yarrowi*) are found in both the Colorado and the Rio Grande, while not a single species is common to both the Colorado and the Wabash basins.

The *Centrarchidæ*, *Percidæ* and *Siluridæ* (sunfishes and basses, darters and catfish), which constitute such a large and important part of the fish-fauna east of the Rockies, have no representatives in the Colorado basin.

SKELETONS OF ZEUGLODON.

Last November Mr. Charles Schuchert collected for the U. S. National Museum portions of two skeletons of Zeuglodon, and these are being used as the basis of a restoration of the entire skeleton for the Atlanta Exposition. Mr. Schuchert has devoted much time to 'developing' the material which promises to throw some needed light on certain portions of this interesting form. The radius and ulna, for example, are present and are more seal-like than cetacean. The hyoid suggests that of a Manatee, and the cervicals present a good

example of animal mechanics, being interlocked so as to be quite rigid. No traces of hind limbs have as yet come to light, but that section of the skeleton where they might have been was unfortunately defective. The material will be described at length in a Bulletin of the National Museum.

Apropos of Zeuglodon Mr. Schuchert characterizes the statement that their remains are so plentiful as to be used for building stone wall as a myth, but it will doubtless continue to live on in text-books in company with the figure of the pouched rat with everted pouches, which has held its place ever since the first description of the animal and seems likely to last indefinitely.

F. A. L.

SCIENTIFIC NOTES AND NEWS.

THE BOTANICAL SURVEY OF NEBRASKA.

IN the *American Naturalist*, for June, Professor Charles E. Bessey gives an account of the 'Progress of the Botanical Survey of Nebraska.' The Survey, though a private enterprise, has received encouragement and support from the State Board of Agriculture, the State Horticultural Society and from the University of Nebraska, the work being in the hands of a 'Botanical Seminar' composed of Graduates of the University. The first important work issued by the Survey was H. J. Webber's 'Catalogue of the Flora of Nebraska,' published in 1890 in the Report of the State Board of Agriculture, and also issued as a separate Monograph. In it 1,890 species were enumerated, almost equally divided between flowering and non-flowering plants, nearly all of which were based on actual specimens in the possession of the author. Since this time the work has been steadily continued and the results have been published at frequent intervals, so that the list of known species now catalogued reaches about 3,050. Additional studies have been made in special directions on the distribution of species. Of the 64 trees and 77 shrubs known to occur in the State the distribution is already well ascertained. The final Report of the survey is in preparation. It will be entitled the *Flora of Nebraska*, and will be issued in twenty-five parts of about 50 pages each. Part I. and part II. were issued in August, 1894 (reviewed in SCIENCE, Jan. 4, p. 25), and part XXII. *The Calyciflora* is now in press.

M. ANDRÉE'S POLAR EXPEDITION.

A COMMITTEE of the Paris Academy of Sciences, consisting of MM. Faye, Daubrée and Blanchard, have reported on the project of M. Andrée to explore the polar regions by baloon. They state that under the circumstances he is likely to reach the pole and will be able to solve many problems of scientific interest. But they fear that the return to inhabited regions will involve serious difficulties.

In the meanwhile M. Andrée is in Paris superintending the construction of a balloon. The balloon is to be of sufficient size to carry three persons, scientific instruments and provisions for four months and a boat transformable into a sledge, weighing in all about 3,000 kg. Gas under pressure in cylinders will be taken in order to refill the balloon from time to time—sufficient to keep the balloon in the air for thirty days.

M. Andrée expects to start from one of the Norwegian Islands of the Spitzbergen Archipelago situated to the extreme northwest of the mainland. July is fixed as the month of departure. A clear day will be chosen with a south wind. The balloon will travel at a minimum rate of 27 km. an hour, and M. Andrée hopes to reach the pole in a voyage of forty-three hours and to return safely to the inhabited regions of North America or Siberia.

According to an account in the *Revue Scientifique* by M. Ch. Rabot, the meteoro

logical conditions of Spitzbergen are very favorable for a long æronautical voyage. The sun in July never sinks below the horizon, and the variations of temperature are consequently very slight. The lowest temperature observed in July, 1883, at Cape Thordsen, was +0°.8 and the highest, +11°.6. At Spitzbergen, during the first fortnight in August, 1892, the largest daily variation observed was 3°, and as a rule it was not greater than 1°.5. The movements of the baloon would therefore be very regular. There is no storm to be feared in the polar regions. The rainfall is small, and a fall of snow at this time of the year would be no obstacle to the baloon.

THE UPPER REGION OF THE ATMOSPHERE.

According to the *London Times*, at the last meeting of the Royal Institution for the present season Professor Alfred Cornu, F. R. S., of the Paris Academy of Sciences, delivered an address in French on the 'Les Phénomènes Physiques des Hautes Régions de l'Atmosphère.'

M. Cornu began by comparing the atmosphere to an immense thermo-dynamic engine, the sun being the source of heat and the interplanetary space the condenser. The most interesting phenomena took place in the almost inaccessible parts of the atmosphere, and though the difficulties of getting information about those elevated regions were great, yet he hoped to show that the physicist was beginning to know much of the real explanation of natural phenomena and was even able to reproduce them in his laboratory. Among the unexpected static phenomena discovered by ballooning and in mountain observatories M. Cornu instanced three—namely, the facts that many clouds which had generally been regarded as consisting of vapour were composed of minute crystals of ice; that at different heights the direction of the wind was different; and that the temperature did not get steadily lower as the earth became more distant, but that alternate layers of hot and cold air were encountered. The first and last of these facts might have been ascertained by indirect means from consideration of certain optical phenomena. From the solar halo might be inferred the presence of ice crystals in cirrus cloud; they had the power of refracting light, and refraction of the sun's light by passing through cloud would fully explain the halo. It could be reproduced artificially by passing a beam of light through a strong solution of alum, with a little alcohol added. The alternations of heat and cold in the atmosphere were deducible from the various forms of mirage, which depended on the reflection of light from the surface of the different layers. M. Cornu gave an ingenious reproduction of the 'Alpine glow,' sometimes seen in the Bernese Oberland, for an example. A valley between two peaks would become filled with hot air under the influence of the sun, and the path of the rays of light reflected from the surface of the hot layer would be convex as regarded from the earth. After sunset the hot air would rise and the cool take its place, thus producing a hot layer of air above of a cooler one. The light from the sun would now be reflected into a concave ray, which would bend down and illuminate the mountain, though the sun was in fact below the horizon. M. Cornu then proceeded to speak of the dynamic phenomena of the air. He said that the solar energy was of three kinds—mechanical energy (appearing as winds, cyclones, etc.), calorific energy (shown by the change of the state of matter, as of water into vapour), and electrical. He only proposed to deal with the first of these. The wind was the most simple mechanical manifestation and had its origin in the difference of atmospheric pressure in two distant places. It never blew in the direction of the line join-

ing the points of greatest and least pressure, but always obliquely to the isobarometric lines, and usually with a circular movement round the points of highest and lowest pressure. When from any cause the equilibrium of the atmosphere was broken down, circular movements of enormous force, such as tornadoes and cyclones, were set up. The lecture concluded with the exhibition of an artificial waterspout.

LIGHTNING IN THE UNITED STATES.

THE U. S. Department of Agriculture has issued a bulletin on *Protection from Lightning* by Mr. Alexander McAidie, which gives some interesting statistics concerning the prevalence of injury from lightning in the United States.

In 1891 the Weather Bureau issued to its observers instructions to report at the end of every month the names, with corroborative dates and places, of all persons killed by violent wind storms, tornadoes and lightning, as also damage to property.

There were reported in 1891, 204 persons killed; in 1892, 251; in 1893, 209, and in 1894, 336. In addition to those killed during 1894, 351 persons were severely injured. The injury to property during the year was as follows: 268 barns struck with a damage of $407,500; 55 churches struck, damage unknown; 261 dwellings and several oil tanks, factories and elevators, the damage amounting to not less than $351,000.

The report strongly recommends the use of lightning conductors in thinly settled districts, but does not give statistics concerning the relative amount of protection supplied by them.

GENERAL.

DANIEL CADY EATON, professor of botany in Yale University, died on June 29th at the age of sixty years.

THERE will be held at Paris in 1896 an *International Congress of Applied Chemistry*. The committee of organization met at Paris on June 4th to make preliminary arrangements, and decided on the ten sections in which the Congress should meet.

THE Division of Ornithology and Mammalogy, Department of Agriculture, has in press a Bulletin by Professor Beal on the Food of Woodpeckers, an abstract of which was recently given in SCIENCE. Mr. F. A. Lucas has contributed a short chapter on the tongues of woodpeckers, and the relation between the character of the tongue and the nature of the food. He concludes that modifications of the tongue, at least external modifications, are directly due to peculiarities of food or feeding, and are not of taxonomic value.

THE removal of Professor George Davidson, head of the Coast and Geodetic Survey on the Pacific Coast, is severely criticised. Telegrams have been sent protesting against this action from Senators Perkins, White and Allison, and from many others. The officers of the Lick Observatory sent the following dispatch:

LICK OBSERVATORY, July 2d.

To President of the United States, Washington:

The undersigned, astronomers of the Lick Observatory, respectfully call your attention to an act of great injustice done to one of the most active and efficient of our Government employees, Professor George Davidson, for many years connected with the United States Coast Survey, who has been removed from his position. Recently published scientific records demonstrate that he is still one of the most active workers in the Survey. It would be an act of simple justice to reinstate him. We earnestly request you to cause this to be done. Respectfully,

E. S. HOLDEN,
J. M. SCHAEBERLE,
E. E. BARNARD,
W. W. CAMPBELL.

MR. GEORGE S. DAVIS has decided to discontinue the publication of *The Index Medicus*. In a circular letter to the subscribers he states that since 1885 the loss has been between $500 and $1,000 annually, and that it would probably amount to $2,000 in

1895. The discontinuation of *The Index Medicus* will be a serious loss to medical science throughout the world.

Science Progress, which since its establishment a year and a half ago, has maintained a high standard as a monthly review of current scientific investigation, will hereafter be published in America by D. C. Heath & Co.

Dr. Friedrich Tietjen, professor of higher mathematics in the University of Berlin and director of the bureau of calculation of the observatory, died at Berlin on June 22d.

Dr. P. A. A. S. Verneuil, professor of surgery in the Hotel-Dieu and eminent for his contributions to surgery, died near Paris on June 11th at the age of 71 years.

Dr. Leonard Stejneger has been sent by the United States Fish Commission, with the permission of the State Department of Russia, on a special mission to the Commander Group of Islands with a view to investigating the fur seals.

Mr. Willis N. Moore, now in charge of the forecasting office of the Weather Bureau at Chicago, has succeeded Professor Mark W. Harrington as Chief of the Weather Bureau.

Dr. Hans Wilhelm Meyer, of Copenhagen, died at Venice on June 3d at 71 years of age. His method of removing so-called allenoid vegetations from the lymphoid tissue in the post-nasal space is regarded as one of the most important advances of modern surgery. These growths are said to occur in more than one per cent. of all school children and to be a foremost cause of deafness and deficient bodily and mental development.

M. Daubrée announced, at the meeting of the Paris Academy of Sciences on June 4th, that Dr. Nordenskjold, professor of mineralogy, geology and geography in the University of Upsala, Dr. Dusen and Dr. Ohlin will undertake a scientific expedition to Terra del Fuego, in September next, with the coöperation of the Swedish and Argentine governments.

An expedition into central Africa will shortly be undertaken under the auspices of the Italian Geographical Society, and under the direction of the explorer Captain Bóttego. The party will include the geologists, Prof. de Stefani, of Florence, and Prof. Bucca, of Catania, and the biologists, Prof. Vinciguerra, of Genoa, and Dr. Sacchi, of Rome.

At the Commencement Exercises at Yale University, Prof. George Fisher introduced a resolution of regret, which was unanimously adopted, on the death of Prof. James Dwight Dana. He announced that if $4,500 more were raised, a pedestal and bust of the late professor would be erected on the campus.

The neurologists of the United States have subscribed about $800 towards the monument to be erected in honor of Charcot. The sum of about $8,000 has been collected for this purpose.

Mr. R. F. Stupart has been appointed director of the meteorological service of Canada.

Sir George Hornidge Porter, regius professor of surgery in the University of Dublin, died on June 20th, at the age of 73.

Dr. Joseph S. Shaw, professor of chemistry at Rock Hill College, Ellicott City, Md., died suddenly on June 27th.

A 'conference of evolutionists' was held at Eliot, Me., from July 6th to 13th. Among the speakers expected were Prof. E. D. Cope, Prof. E. S. Morse, Mr. John Fiske and Dr. L. G. Janes.

It is stated in *Nature* that the first number of a bimonthly journal for sanitary engineers will be published at Brussels on August 1, under the title *La Technologie Sanitaire*. It will be under the direction of an edi-

torial committee, the secretary of which is M. Victor J. Van Lint, 115 rue Joseph II., Bruxelles. The journal will deal with all questions relating to public health.

L'Association francaise pour l'avancement des sciences will hold its twenty-fourth session at Bordeaux, August 4th to 9th.

ACCORDING to the Monthly Bulletin of the Board of Health of the State of New York the average daily mortality for the month of May was 308 as compared with 368 for the preceding four months of the year. The improvement was due to the suspension of the epidemic of grip, which began in January.

ARRANGEMENTS are being made by the Marine Biological Association [England] for a series of dredging and trawling expeditions during July, August and September, to investigate the fauna and flora of the outlying grounds between the Eddystone Rocks and Start Point. In order to make the results as complete as possible, it is extremely desirable that the investigation of each group should be carried out by a competent naturalist. Zoölogists and botanists who are willing to take part in these expeditions, or to assist in working out the material collected, are requested to communicate with the director, the Laboratory, Plymouth.—*Academy.*

EDUCATIONAL AND UNIVERSITY NEWS.

ON July 29th Judge Ross, in the United States District Court, San Francisco, made a decision in favor of the Stanford estate against the claim of the Government for $15,000,000.

DR. CARL BARUS, of the Smithsonian Institution, Washington, has accepted the Hazard professorship of physics in Brown University. It is stated that Brown University has recently spent $100,000 in the building and equipment of a physical laboratory.

A NEW edition of the quinquennial catalogue of Harvard University has been issued from the University press. It now requires a volume of 515 closely printed octavo pages to include the officers and graduates of the University since 1636.

DR. THEOBALD SMITH, Chief of the Division of Animal Pathology in the Bureau of Animal Industry, Department of Agriculture, has been offered a professorship in Howard University.

GEORGE WILLIAM SMITH, who recently declined the presidency of the University of Kansas, has been elected president of Colgate University. He is now professor of history in Colgate University.

MR. ARTHUR F. NESBIT, of Milton, Pa., graduate of the Massachusetts Institute of Technology, has been appointed instructor of physics and electrical engineering in the New Hampshire College of Agriculture.

THE quarterly statement of President Harper, of the University of Chicago, shows that the teaching staff of the university at present consists of 164 professors and instructors. The total enrollment of students for the year has been 1587, and for the summer quarter between 600 and 700 have already registered. The trustees of the Ogden estate have added $50,000 to the sum already given to the University.

THE University of Vermont has bought for $12,000 a house at Burlington which will be used as a dormitory for women students.

IT is stated that Dr. Pearsons has offered on certain conditions to give $50,000 each to Berea College and Whitman College.

THE buildings of the University of Missouri destroyed by fire January 9th, 1892, have now been rebuilt at a cost of $500,000. Seven new buildings are ready for use, including a chemical building, a biological and geological building and a physical and engineering building.

An effort is being made to collect $5,000 to improve the library at Wesleyan University. Mr. J. E. Andrus has pledged $1,000 on condition the rest be raised.

The Society of the New York Hospital has sold to Barnard College, for $160,000, a site on the west side of the Boulevard, between 119th and 120th Streets.

The *Naturwissenschaftliche Rudschau* states that Professor v. Kries has declined the call to the chair of physiology in the University of Leipzig.

At Zurich Dr. Hans Schinz has been promoted to a full professorship of botany, and Dr. A. Werner to a full professorship of chemistry.

Professor Trendelenburg has been called to take Professor Thiersch's place in Leipzig. Professor Mikulicz takes Professor Trendelenburg's place in Bonn.—*N. Y. Medical Record.*

The Senate of the University of Cambridge has resolved, by a majority of 18 votes, to make an English essay a part of the 'Little go,' or preliminary examination.

The statute on research degrees at Oxford, which we have already mentioned as of special interest to Americans proposing to study abroad, has passed its final stage in convocation without opposition.

Dr. Henry Calderwood, professor of moral philosophy in the University of Edinburgh, has requested to be retired from the chair in view of his candidature for Parliament.

At Oxford, on June 17th, the proposal for establishing a Final Honour Examination in Anthropology in the School of Natural Science was discussed in Convocation, and the statute was rejected by 68 votes to 60. According to *Nature* the rejection was due to 'theological suspicions' and 'those classical teachers that believe that science may safely be ignored in a nineteenth century education.'

The seventh summer meeting of university extension and other students will be held this year at Oxford, and will be divided into two parts, the first lasting from August 1st to August 12th, and the second from August 12th to August 26th. Included in the varied course there will be lectures on natural science during both parts of the meeting, and classes will be formed for practical work in the different divisions. Among those who have promised to lecture are Professors Green and Odling; Drs. Fison and Wade; Messrs. Carus, Wilson, Marsh, Groom and Bourne.

CORRESPONDENCE.

A BIBLIOGRAPHY OF SCIENTIFIC LITERATURE.

To the Editor of Science: With your permission, I will make a few observations on a plan which I have been steadily working out for the last 35 years, more especially as it embodies many of the suggestions which have recently been made by some of your correspondents. It embraces:

1. A *Bibliography* classified according to subjects arranged: (1) according to the year of publication, and (2) alphabetically under each year according to the name of the author; each item has its distinctive number for reference purposes.

2. An *Index*, which, although arranged alphabetically, is classified in groups more than is usual in an index, the object being to render it possible, at some future time, to amalgamate the various subject indexes into one general classified index.

3. A *Systematised Collocation of Facts* grouped according to their relationship to each other. The aim of the whole is to enable any person engaged in scientific research to find the information he seeks with a minimum expenditure of trouble, time and cash.

In its entirety the idea is thoroughly Utopian; nevertheless, I feel very confident that if only partially carried out it would

afford considerable assistance to many workers.

The method pursued has been to take up literary items in succession, be it a paper, a volume or a series of volumes (for a plentiful supply of which I am indebted to many of your countrymen), to thoroughly analyze the contents and to place the data under their appropriate headings, care being taken to eliminate all useless repetition. As the subject-matter is divided up into a very large number of headings, the result is the focalization of the data in a systematic sequence, so as to bring into close contiguity the facts bearing on the headings which were originally widely scattered in scientific literature.

The generical idea is simple enough, but the practical realisation of it is sometimes attended by many difficulties, and involves a great multiplicity of details which can not be described in the limits of a letter; but some notion may be formed of the scope and extent of what has been done, if a summary is given of the matter already collected under the heading 'Animalia: General.'

The *Bibliography* arranged chronologically by years and alphabetically by authors' names subordinate to the year, at present numbers between 30,000 and 40,000 titles on about 5,000 slips. *General;* for notes of the most general kind, or of an indefinite character; this covers about 50 slips. *Descriptive;* about 30 slips. *Classification;* about 100 slips, arranged chronologically by years, a remark which applies to all headings. *Affinities;* about 70 slips. *Characters;* about 200 slips; arranged by groups (Class, order, etc.) *Organic grade;* about 3,600 slips. This is an attempt to arrange all groups according to their apparent grade on an organic scale, in which the lowest animal is considered to be 1, and the highest 1,000,000. I believe there is a certain amount of novelty in the idea of numerically externating organic grade, and therefore I venture to make an extract from the slip which refers to the grade range 55,001–56,000. This is considered to be the highest limit of the sub-kingdom *Protozoa*. The class *Infusoria* and the order *Ciliati* extend through it and termimate with it. The following families are comprised in it:

Oxytrichina, 55,001–55,100.
Urocentrina, 55,101–55,550.
Vorticellina, 55,551–56,000.

The following genera are comprised in it:

Stylochæta, 55,001–55,033.
Oxytricha, 55,034–55,100.
Urocentron, 55,200–55,300.
Trichodinopsis, 55,551–55,584.
Spirochona, 55,585–55,618.
Trichodina, 55,619–55,642.
Lagenophrys, 55,643–55,676.
Vaginicola, 55,677–55,710.
Cothurnia. 55,711–55,744.
Ophrydium, 55,745–55,789.
Gerda, 55,790–55,824.
Scyphidia, 55,825–55,859.
Epistylis, 55,860–55–894.
Zoothamnium, 55,895–55,929.
Carchesium, 55,930–55,964.
Verticella, 55,965–56,000.

It is not supposed for one moment that these figures have any claim to strict scientific accuracy. In this respect they are coequal in value with the classification on which they are based; their special advantage is that they enable a person to give definiteness to his views as to the position of any form, and hence afford a ready means of comparing any number of different views. For instance, if Rolleston's classification were adopted, the apparent place of *Verticella* would be at about 142,800. This not only shows a difference of opinion, but also the extent of it; this definiteness is calculated to be of great advantage in carrying on discussion.

Systemic : general; about 500 slips.

Systemic : general : Chemical substances; about 3,000 slips.

There is, I think, a certain amount of novelty in the mode of grouping under this heading, but it would occupy too much space to draw any further attention to this feature. Under this heading each substance found in the bodies of animals has its own set of slips. Particulars are entered bearing upon its chemical composition, chemical constitution, the processes of formation (actual and hypothetical), the changes which it undergoes in the animal body, and (in a general way) its modes of occurrence in the different systems of organs. The full details are given in connection with each organic system.

Under Systemic: General; there are also grouped, the notes relating to *Development*, *Cells* and their differentiated parts, each part having its own set of slips. *Chondroites*, *Cilia*, *Animal Magnetism*, *Animal Electricity*, and a few other minor subheadings; these cover about 100 slips. *Absorbent System*; this covers about 250 slips, and is broken up into various subheadings subordinate to *Lacteal* and *Lymphatic Subsystems*. *Alimentary System;* about 1,500 slips. Each particular part has its own set of slips. Under *Bile* each chemical substance found therein has a special set of slips devoted to it; at present there are 65 such substances dealt with in the notes. Under *Food*, also there are a number of subordinate headings: *Circulatory System*, about 1,200 slips. *Generative System;* about 200 slips. *Glands;* about 700 slips. *Muscular System;* about 500 slips. *Nervous System;* about 900 slips. *Osseous System;* about 800 slips. *Respiratory System;* about 300 slips. *Senses;* about 500 slips. *Tegumentary System;* about 300 slips. *Tissues;* about 500 slips. *Urinary System;* about 600 slips. *Habits;* about 150 slips. *Medial Influence;* about 3,200 slips. *Geological Distribution;* about 2,500 slips. This is arranged by periods, and under each period there are separate sets of slips for each country or subdivision of a country, such as county, etc. *Geographical Distribution;* about 400 slips.

The whole number of slips relating to animals regarded from a general point of view is about 27,000.

Each class of animals has separate treatment, the facts being mostly grouped together under the main headings above enumerated for animals in general, subordinated to the name of each genus.

Notes have been collected more or less fully under most of the classes, so that few comprise less than 5,000 or 6,000 slips, while some comprise a great many more than that.

The notes under some of the non-zoölogical subjects are also more or less bulky. Thus *Stratigraphy*, *Minerals* (including chemical substances), *Ocean*, *Water* and some others each exceed 30,000 slips.

The slips I use measure eight inches by five inches, and are arranged in book boxes lettered on the back with the name of the subject-matter in the box. Each slip is headed with all the main and subordinate headings appertaining to it and numbered. By taking care that the size is kept uniform there is little risk of the edges being turned back, of the corners being dog-eared, or of the surfaces becoming dusty or soiled. They have all the advantages of cards, occupy much less space and are more easily handled, as each book box is the size of a thick octavo volume.

In conclusion, I wish to thank you for allowing me to occupy so much of your space.

A. Ramsay.

London.

Hack Tuke Memorial.

The great respect in which the late Dr. D. Hack Tuke was held by all who knew him has led to a very generally expressed desire that his memory should by perpetuated in connection with the great work to which

he devoted his life, viz., the amelioration of the condition of the insane, and the progress of neurological and psychological medicine.

With the view of carrying out this object, an influential and representative committee has been appointed, and they are of opinion that the memorial should take the form of a prize or medal to be awarded as an encouragement to the study of the above-mentioned subjects.

The committee venture to make an earnest appeal to all those who desire to honor the memory of Dr. Tuke and to promote his life's work, for subscriptions to carry out this object.

The subscriptions may be sent to the Honorary Treasurer, Henry Rayner, M. D., 2 Harly street, London, W.

G. F. BLANDFORD, M. D.,
Chairman.

SCIENTIFIC LITERATURE.

L 'Année psychologique. Première Année, 1894. Publiée par MM. H. BEAUNIS et A. BINET. Alcan, Paris, 1895. Pp. vii., 619. 10 francs.

This new annual combines two main features, both of which will prove of interest and value to psychologists: it publishes the results of the investigations undertaken at the psychological laboratory of the Sorbonne, together with some other original articles, and a general review on some important question; and it gives an extended analysis and bibliography of all the important psychological literature which appeared in 1894. With the largely increasing mass of literature appearing in this field, the latter feature will render the annual extremely helpful. As to the original matter, every one who is familiar with the previous work of M. Binet, the director of the laboratory, will be assured beforehand of its high quality, its thoroughness and its insight.

I. After a brief introduction by M. Beaunis, we find the original articles occupying in all 255 pages. They are as follows:

(1) A. Binet and V. Henri: *Memory for Words* (Pp. 1–23). The number of isolated words retained after a single hearing varies with age and with the number of words heard; only one-third to one-half as many are preserved in memory as can be repeated immediately after hearing them read; the first and the last words heard are the ones best retained; in immediate repetition, errors of sound, and in later repetition, errors of sense predominate. Errors of omission are much more numerous than errors of imagination, where for one word is substituted another entirely different. The principles of contiguity and of resemblance are not sufficient to account for the recall of particular words; the direction of the attention towards the experiment as a whole is a further essential condition.

(2) A. Binet and V. Henri: *Memory for Phrases* (for ideas). (Pp. 24–59). The number of words retained was found, under the conditions of the experiment, to be about 25 times as great when they occur in connected phrases as when they are isolated.

(3) A. Binet and J. Passy: *Psychological Studies of Dramatic Authors.* (Pp. 60–119). This paper gives the results of an attempt to throw light on the question of the creative imagination by means of interviews with Victorien Sardou, Alexandre Dumas, Alphonse Daudet, Edouard Pailleron, Henry Meilhac, Edmond de Goncourt and François Cåppée. The following results were attained: (1) The work of literary composition does not manifest itself in any exceptional physical or moral condition distinguishing it from other mental occupations. The belief in an 'artistic hallucination,' as well as in the importance of the influence of the seasons, of the environment, of artificial excitants, is unfounded. The work of artistic creation demands full

self-possession, and depends not only on the imagination, but also on reason and common sense. (2) The sole effective excitation to work is of psychological nature; the author finds himself in a particular emotional state, which originates directly in the subject treated. (3) The work of dramatic composition takes place most frequently under the form of crises—longer or shorter periods during which production is especially easy. (4) As to the mental state during composition, the author may simply attribute to his characters his own ideas and emotions; he may seek to forget his own personality, and to enter into that of the characters he imagines; or he may be in a state which may be truly called one of inspiration, where he seems to listen passively to the conversation which his characters themselves carry on. (5) With few exceptions, the professional dramatic authors, when they compose, represent the scene to themselves as occurring on the stage of a true theatre. (6) The question of mental images is one of little importance in composition.

(4) A. Binet: *François de Curel* (pp. 119–173). This paper continues the previous one, and is given separately because the observations furnished by Mr. de Curel are so abundant and so precise as to constitute probably the most complete analysis in existence of the creative imagination. M. de Curel's mental state during composition is of the third type mentioned in the previous paper, that of inspiration.

(5) Weeks: *Experimental Researches in Phonetics* (pp. 174–178). Contrary to the received opinion the South German consonants b, d, g, whether at the beginning, in the middle, or at the end of a word, are weaker than p, t, k, instead of identical with them.

(6) Th. Flournoy: *The Action of the Environment on Ideation* (pp. 180–197). Forty-three persons each drew ten designs and wrote ten isolated words. The immediate environment was responsible for 15.7% of the drawings, 37.2% of the words; individual habits, profession, etc., accounted for 41.6% of the designs, 31.1% of the words.

(7.) Th. Flournoy: *A case of personification.* (Pp. 191–197.) A rare phenomenon, similar in nature to colored hearing, visual schemes, etc. It consists in the concrete representation of a person (or animal or object) regularly aroused by a word or an idea which has no comprehensible relation with this associated image.

(8.) Th. Flournoy: *The influence of the visual perception of bodies on their apparent weight.* (Pp. 198–208.) Smaller objects of equal weight seem heavier than the larger if they are looked at while the comparison takes place. The illusion persists, even when the equality of weight is known, and does not depend on the mode of prehension or upon inequalities of cutaneous contact. Of two equal weights occupying a volume of 2100 and 10 ccm. respectively, the smaller was judged to be from two to five times as heavy as the larger. This experiment proves that the sensation of motor effort is purely kinæsthetic, and that so-called sensations of innervation have no existence.

(9.) E. B. Delabarre: *The Laboratories of Psychology in America.* (Pp. 209–255.) A brief account of the development of Psychology in America is followed by a detailed description of the psychological laboratories. These number 27, of which 8 or 9 are for demonstration only; some 5 to 8 devote some attention also to research; and 10 or more are especially active in research. In connection with each laboratory are given the names of director and instructors; list of courses; date of establishment of the laboratory, number of rooms occupied, value of equipment and annual appropriation, and kind of research for

which it is especially fitted; library facilities; scholarships and fellowships open to students; lists of apparatus invented, researches published and in preparation, and other publications by the instructors.

II. The second part of the *année* is headed 'Bibliographie,' and consists of analyses of nearly 200 books and articles (pp. 257–528), of a description of new apparatus (529–534), and of a necrology (535–538).

III. In a third part is placed a bibliographical table of 1217 titles, provided with an index of authors. The classification of this bibliography, which differs slightly from that of the analyses of the second part, is the following: Psychological treatises; articles on general psychology; normal and pathological anatomy and histology of the central nervous system; physiology of the nervous system; psychological methods; physiology and anatomy of vision; visual sensations; audition; sensations of the skin; gustatory and olfactory sensations; movements; fatigue; emotions; memory; psychometry; attention; association; individual psychology and character; scholastic psychology (pedagogy); heredity and evolution; criminal psychology; hypnotism, suggestion and sleep; aphasia; mental and nervous pathology; anthropology; comparative psychology.

The first five articles of part I. do not represent all the work accomplished in connection with the laboratory of the Sorbonne. A full list, given on p. 179, includes twelve further titles of papers which have been published elsewhere, and which are therefore merely analyzed in part II. It is proposed to retain as a permanent feature of the Année the 'general review on some important question,' represented this year by the paper on American laboratories, in such a manner as to gradually work through the entire field of psychology. General reviews on psychometry, on the graphic method, and on the psychology of vision, are announced as probable.

E. B. DELABARRE.
BROWN UNIVERSITY.

Iowa Geological Survey. SAMUEL CALVIN, State Geologist. Volume III. being the Second Annual Report (1893) and accompanying papers. Des Moines, 1895, pp. 501, plates XXXVII., figs 34.

In July, 1892, the present Geological Survey of Iowa took the field, and up to date three volumes have been issued. These are the Annual Report for 1892, issued 1893; the Coal Deposits of Iowa, issued 1894; and the Annual Report for 1893, the volume here under consideration. Iowa is more widely known for its agricultural than for its mineral resources, but the latter are none the less of extreme importance. In coal there is a vast productive area and an annual output of five million tons. The great beds of gypsum near Fort Dodge are now being adequately developed, and in not a few places throughout the State the less conspicuous industries of brick, pottery and building stone are coming into prominence. It is not intended to imply that agriculture is in any degree less benefited by a geological survey than these other industries, and the reports in question give evidence that this fact has been well appreciated by the State Geologist. The wise manager in an office of this kind carries on, behind the breastworks of economic geology, all the purely scientific work that his constituency will bear. Professor Calvin seems to have nicely adjusted these relations.

Passing over the routine reports, the work before us contains the following special papers:

H. F. Bain describes the 'Cretaceous Deposits of the Sioux Valley,' pp. 101–114. The classification of the cretaceous is more accurately carried out for this region than

had been previously done, and the importance of this formation in Iowa, a fact that we are just beginning to appreciate, is still further brought out.

W. H. Norton, 'Certain Devonian and Carboniferous Outliers in Eastern Iowa,' pp. 117–133. Both these formations are represented east of their main areas, but whether the outliers have or have not been cut off by erosion is still undecided.

J. L. Tilton, 'Geological Section along Middle River in Central Iowa,' pp. 137–146.

C. R. Keyes, 'Glacial Scorings in Iowa,' pp. 149–165. The paper describes and tabulates striæ in all four quarters of the State. The general directions are between south and east.

W. H. Norton, 'Thickness of the Paleozoic Strata of Northeastern Iowa,' pp. 169. This important paper is based on well records obtained from holes sunk both for water and oil or gas. These valuable records are usually so evanescent that to have so many preserved is a matter of congratulation.

C. R. Keyes, 'Gypsum Deposits of Iowa,' pp. 259–304. This report is a welcome addition to the scanty literature of an important industry. Iowa is now fourth among the States as a producer of plaster and has great reserves of the crude rock for the future.

C. R. Keyes, 'Geology of Lee County,' pp. 307–407. Lee county forms the southeastern corner of the State. The paper reviews its geology with thoroughness and with good illustrations.

C. R. Keyes, 'Economic Geology of Des Moines County,' pp. 411–492. This county adjoins Lee on the north. After an introductory geological sketch, the building stones, clays, coal and other minor economic minerals are taken up.

The typography and general style of the volume are excellent and reflect credit on the management of the Survey. Since its issue Dr. C. R. Keyes has become State Geologist of Missouri, and H. F. Bain has become Professor Calvin's chief assistant, making thus some recent changes of personnel in the staff. J. F. Kemp.

HYGIENE.

Annual report of the Department of Health of the City of Chicago for the year ended December 31, 1894. Arthur R. Reynolds, M. D., Commissioner of Health, Chicago. 1895. 268 pp., 8°.

Dr. Reynolds remarks that "the phenomenal healthfulness of the city continues to be the theme of incredulous comment by less favored localities." When a death rate of 15.24 per 1,000 is reported for a city of a million and a half of people it is very apt to be the subject of incredulous comment by statisticians, who are skeptical about municipal death rates of less than 17 per 1,000, knowing that there are several ways of lowering death rates besides the primitive one of reducing the number of deaths. It is clear, however, that there were but 23,892 deaths reported in Chicago during the year 1894 as against 27,083 in 1893; 26,219 in 1892, and 27,754 in 1891, and that, therefore, the death rate must have been comparatively low last year, as it was in almost all large cities.

The account of the small pox epidemic is interesting. 2332 cases were received in the city small pox hospital. 993 of these had been vaccinated after some fashion, and of these 161, or 16.2 per cent., died. 1339 had not been vaccinated, and of these 485, or 36.2 per cent., died. The difference was most marked in the children under 6 years of age, in whom the mortality of those vaccinated was 12.5, and of those unvaccinated 44.0 per cent. The chronological summary of Chicago mortality from 1851 to 1894, with diagrams, is interesting and valuable. The report, as a whole, contains a vast amount of information and is highly creditable to the department which issues it.

Handbook of Sanitary Information for Householders. By ROGER S. TRACY, M. D., 114 pp., 16°. New York, D. Appleton & Co. 1895. Price, 50 cents.

This little book is intended especially for the information of householders in the city of New York, and is, in most respects, well adapted to its purpose. The section on house plumbing is the fullest and best. The section on disinfection is behind the times by about 12 years; sulphate of iron is not now considered to be a disinfectant, but merely a deodorant, and no allusion is made to the disinfectants now most relied upon, viz.: chloride of lime, mercury bichloride and carbolic acid.

The warning against inhaling the breath of persons affected with diphtheria and consumption is unnecessary, and diverts attention from the real source of danger, which is correctly stated to be the discharges from the throat, nose and lungs. There are no bacteria, specific or other, in the expired breath in ordinary respiration.

SCIENTIFIC JOURNALS.

THE AMERICAN GEOLOGIST, JULY.

Remarks on the Genus Nanno, Clark. By ALPHEUS HYATT.

This interesting genus of cephalopods was first described by Professor J. M. Clarke (Am. Geol., Oct., 1895). The present author has made a more extended and detailed study of the type specimens, which were from the Lower Silurian of southeastern Minnesota. The paper is accompanied by a half-tone plate showing several sections of the fossils.

Steps of Progressive Research in the Geology of the Lake Superior Region prior to the late Wisconsin Survey. By N. H. WINCHELL.

This paper is the fifth in a series entitled 'Crucial Points in the Geology of the Lake Superior Region.' Beginning with the Canadian Geological Survey, the various steps of progress are traced down to the commencement of the Wisconsin Survey. Among other things the origin and use of the term Huronian is explained and some misapplications of that term are noticed.

Actinophorus Clarki, Newberry. By E. W. CLAYPOLE.

The discovery of another specimen of this fossil fish by Dr. Clarke, of Berea, Ohio, after whom the fish was named, has furnished Professor Claypole with data for a morec omplete description than was possible when the type was first described by Professor Newberry.

Camptonites and other Intrusives near Lake Memphremagog. By V. F. MARSTERS.

Quite a number of dykes, both granitic and lamphrophyric, have been found on the shores of this lake. The following lamphrophyre dykes are described: Diabase, camptonite, augite camptonite, monchiquite and fourchite. An important feature of the paper is a summary of the literature on other occurrences of monchiquite and camptonite.

The Kame-Moraine at Rochester, N. Y. By H. L. FAIRCHILD.

The Pinnacle hills, at Rochester, with which this paper deals, have long been known to glacialists, but no detailed description of them and of their origin has before been attempted, except by Mr. Warren Upham, who regards them as of the nature of eskers. Professor Fairchild has lately investigated these hills, and the present paper is a rather complete abstract of the results of this investigation, which will be published in full in the Proceedings of the Rochester Academy of Science. He regards these hills as constituting a kame series forming part of a frontal moraine.

Under 'Editorial Comment' a considerable review of the present status of the feldspars is given, and the results of the recent optical work of Messrs Michel-Lévy and La Croix is brought forward. Under 'Corre-

spondence' Dr. Geo. M. Dawson presents a note on 'Interglacial Climatic Conditions.' This number includes the usual reviews of recent geological literature, list of recent publications, and personal and scientific news.

THE MONIST, JULY.

THE opening article by Professor Joseph Le Conte, *The Theory of Evolution and Social Progress*, reviews broadly the history of the development-idea and finds that there are four grades or planes of evolution—physical, chemical, biotic and human. To each there is a limit, and the evolutionary process can continue only by being transferred to a higher grade with new factors. The first three have already reached their goals; only the last, rational evolution, remains. Here the significance and character of the new factor—voluntary rational coöperation—which differentiates the new grade from the rest, must be considered in sociological applications. Professor Le Conte emphasises the beneficent and encouraging features of the Lamarckian factors, and counsels strict subordination to wise empiricism in all practical applications of scientific principles.

In *The Present Problems of Organic Evolution*, Professor E. D. Cope, after stating *ipsissimis verbis* the views of Lamarck, Darwin, Wallace, Spencer, Haeckel, Weismann and others, contrasts the doctrines of the two opposed schools of epigenesis and preformation, and sketches the main features of his own theory of the origin and inheritance of variations as based on independent studies, to be developed in full in a forthcoming book.

The Metaphysical X in Cognition, a long and exhaustive article by Dr. Paul Carus, examines and aims to refute the theory of knowledge, now almost universally accepted, which rejects scientific explanation as the ultimate term of cognition, and which finds in science an unknowable metaphysical residuum which the human mind can never hope to compass. Dr. Carus also examines the view of Professor Ernst Mach that ultimate explanations in physics are not necessarily mechanical explanations.

Professor A. E. Dolbear, in *Materialism Untenable*, points out that the possibilities of matter as an active agent are not yet limited. In *The Unseen Universe* Sir Robert Stawell Ball develops in a popular but elegant manner the truth that the objects which we can see in the heavens very probably constitute not a millionth part of the material universe.

In *The Science of Mentation*, Mr. Elmer Gates propounds 'some new general methods of psychologic research.' Mr. Gates lays stress on the results which he has reached by the *artificial* variation (1) of the organic structures and (2) of the mentation of organisms. His color experiments with dogs kept in the dark from their birth and with dogs compelled to distinguish between colors by electric shocks consequent upon certain actions, with the structural results shown by cerebral dissection, are ingenious. The educational inferences of this article, although sweeping, are suggestive.

Mr. E. Douglas Fawcett writes on monadology, and Mrs. Emilia Digby in refutation of the onomatopic theory of music. M. Lucien Arreat's letter on the philosophical literature of France, with reviews of the best and most recent philosophic, scientific and religious works published in America, England, Germany and Italy, constitute the rest of the contents.

NEW BOOKS.

Biological Lectures delivered at the Marine Biological Laboratory of Wood's Holl. Boston, Ginn & Co. 1895. Pp. vii+287.

Analytical Chemistry. N. MENSCHUTKIN. Translated by JAMES LOCKE. London and New York, Macmillan & Co. 1895. Pp. xii+512. $4.00.